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10/538,110	12/14/2005	Robert Frederick Milsom	GB 020223	8868

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EXAMINER	
SUMMONS, BARBARA	

ART UNIT	PAPER NUMBER
2817	

NOTIFICATION DATE	DELIVERY MODE
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ip.department.us@nxp.com

Office Action Summary	Application No.	Applicant(s)	
	10/538,110	MILSOM ET AL.	
	Examiner	Art Unit	
	Barbara Summons	2817	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *08 June 2005 (pre-amendment)*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-12* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-12* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *10/12/06*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Specification

1. The disclosure is objected to because of the following informalities: The entire specification should be reviewed and each occurrence of "wolfram" (see e.g. two occurrences on page 4, line 3) should be changed to - - tungsten - -. On page 6, on line 26, the numbers in the parenthetical expressions of tantalum pentoxide and silicon dioxide should be subscripts. On page 6, line 31, which is the last line thereof, is unreadable, and therefore should be clarified. On page 7, lines 9 and 10, "wolfram" should be - - tungsten - -. Appropriate correction is required.

Claim Objections

2. Claims 3, 5, 6, 8, 9 and 12 are objected to because of the following informalities:

In claim 3, on lines 3-4, the reference signs in parenthesis "(25, 26 or 22, 23)" on line 3 should more appropriately be located on line 4 after "stack of conductive materials" (see also claim 5 where the numbers 22, 23, 25 and 26 are clearly the stacked conductive materials of multilayered top and bottom electrodes).

In each of claims 5 and 6, on line 2, after "stack", a comma should be inserted.

In claim 8, on the next to last line thereof, both occurrences of "wolfram" should be changed to - - tungsten - -.

In claim 9, on line 5, note that "comminations" should be - - combinations - -.

In claim 12, on line 2, ", especially an electro-acoustic resonator" should be deleted. Appropriate correction is required.

3. The claims are objected to because they include reference characters which are not enclosed within parentheses.

Reference characters corresponding to elements recited in the detailed description of the drawings and used in conjunction with the recitation of the same element or group of elements in the claims should be enclosed within parentheses so as to avoid confusion with other numbers or characters which may appear in the claims. See MPEP § 608.01(m).

Specifically, in claim 4 on line 3, and in claim 9 on lines 3-4 each phrase beginning with the reference character "22" and ending with the reference character "26" should be in parenthesis. However, see also the 112 rejection below and the Examiner's suggested changes.

Claim Rejections - 35 USC § 112

4. The following is a quotation of the second paragraph of 35 U.S.C. §112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claims 4 and 9-11 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 4 is unclear because it is clearly directed to the embodiment using a stack of conductive materials for either the top or bottom electrode (see 22, 23 and 25, 26 in Fig. 3), since that is the only time a "diffusion barrier" is used (see also the specification at page 6, lines 6-10). That is, it does not make sense to have a "diffusion barrier"

between the "electrode layers" being the "top" and "bottom" electrode layers recited in claim 1. Therefore, it appears that claim 4 should correctly depend from claim 3. Furthermore, in claim 5, the reference characters 22 and 23 and 25 and 26 refer to conductive materials in a stack forming the electrode layers. The Examiner believes the intended clear meaning of claim 4 to be:

- - Electro-acoustic resonator (1, 8, 17) as claimed in claim 3, characterised in that between the stacked conductive materials of the electrode layers (22 and 23 and/or 25 and 26) a conductive thin diffusion barrier is formed. - -

Claim 9 is unclear because it lacks antecedent basis for "the diffusion barrier" recited on lines 2-3 thereof. Therefore, it appears claim 9 should correctly depend from claim 4. The Examiner believes the intended clear meaning of claim 9 to be:

- - Electro-acoustic resonator (1, 8, 17) as claimed in claim 4, characterised in that the diffusion barrier between the stacked conductive materials of the electrode layers (22 and 23 and/or 25 and 26) consists of titanium nitride (TiN), or titanium (Ti), or consists of combinations of titanium nitride (TiN) and titanium (Ti). - -

Claims 10 and 11, each recite a resonant frequency "in the region of 2 GHz" and electrode layers having thicknesses "in the region of" 200nm/300nm (top/bottom) for the molybdenum electrodes in claim 10 and "in the region of" 50nm/150nm (top/bottom) for the platinum electrodes in claim 12, wherein the recitation of "in the region of" is vague and indefinite since it cannot be understood in light of the specification what range

would be considered "in the region of" the recited values. Would it be ±10nm or 20nm, etc. for example, for thicknesses or ± 10, 20 or even 50MHz, etc. for the frequencies? It especially is unclear regarding the thicknesses of the electrodes since these layers only appear to be partial layers of the total electrodes each being used with an additional aluminum layer (see e.g. the specification at page 7, lines 16-22).

Claim Rejections - 35 USC § 102

6. The following is a quotation of the appropriate paragraphs of 35 U.S.C. § 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

7. Claims 1, 2 and 12 are rejected under 35 U.S.C. § 102(b) as being anticipated by Weber U.S. 5, 864,261.

Fig. 1 of Weber discloses an electro-acoustic resonator 30 that is a solidly mounted bulk acoustic resonator (SBAR) mounted on an acoustic isolator 40 (layers 42-45) on a substrate 20, the resonator 30 having a layer structure comprising a piezoelectric layer 35, a top electrode layer 36 and a bottom electrode layer 37, the two electrode layers being unequal, characterized in that the top electrode layer 36 with a

thickness of 0.2 microns (see col. 7, lines 54-55), is thinner than the bottom electrode layer 37 which has a thickness of 0.3 microns since it is the top constituent of stacked pair 42 (see col. 4, lines 57-58 and col. 7, lines 55-57) of the acoustic isolator 40. Regarding claim 12, such resonators are used in radio frequency filters (see e.g. col. 8, lines 37-40).

8. Claims 1-3 and 12 are rejected under 35 U.S.C. § 102(e) as being anticipated by Bradley et al. U.S. 6,874,211.

Figs. 3A and B of Bradley disclose a device similar to Figs. 1 and 2 (see col. 5, lines 64-67) wherein a typical electro-acoustic resonator at 1,900 MHz has top and bottom electrodes of 1,500 Angstroms thick (see col. 3, lines 45-50), wherein in the embodiment of Fig. 3A-B in resonator 80 the top electrode layer 76 is reduced in thickness by several hundred Angstroms (see col. 6, lines 61-67) so as to be thinner than the bottom electrode layer 72, and wherein the resonator 80 is formed over a cavity (see col. 1, lines 20-26) to be a film bulk acoustic wave resonator (FBAR). Regarding claim 3, Fig. 4 shows an embodiment wherein the top electrode layer 116 and 126 and the bottom electrode layer 112 and 122 are the typical 1,500 Angstroms thick (see col. 7, lines 39-47 and col. 3, lines 45-50), and the bottom electrode includes a stack of conductive materials 112 and 113 that makes it 100 to 1,000 Angstroms thicker than the top electrode layer 116 (see col. 7, lines 41-49). Regarding claim 12 the two resonators 80, 90 or 110, 120 (Figs. 3A-B or 4) having slightly different resonant frequencies form radio frequency filters (see col. 1, lines 45-54 and col. 10, lines 20-22).

9. Claims 1, 3, 4, 6 and 12 are rejected under 35 U.S.C. § 102(b) as being anticipated by Zimnicki et al. U.S. 6,249,074 (cited by Applicants).

Fig. 2 of Zimnicki discloses an electro-acoustic resonator with a layer structure comprising: a piezoelectric layer 12; a top electrode layer formed by a stack of conductive materials 14 and 16, being aluminum and silver or gold, respectively (see e.g. col. 3, lines 13-16) with a conductive thin diffusion barrier 18 (e.g. chrome) between the stacked conductive materials 14 and 16 of the top electrode layer; and a bottom electrode layer 14, wherein the top electrode layer Side 2 (see col. 3, lines 54-55 with col. 4, lines 1-4 and 32-34) has a total thickness of 1100 Angstroms (col. 4, lines 32-34) that is thinner than the bottom electrode layer Side 1 with a thickness of 1500-1540 Angstroms. Regarding claim 6, the conductive material of electrode layer 14 in contact with the piezoelectric layer 12 is aluminum, which inherently has a lower acoustic impedance than that of the higher density gold or silver of layer 16. Regarding claim 12, the resonators are used in RF filters (see col. 5, lines 60-63 and col. 6, lines 20-22).

Claim Rejections - 35 USC § 103

10. The following is a quotation of 35 U.S.C. § 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of

the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

11. Claims 1-5, 7-9 and 12 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Lakin U.S. 6,291,931 taken together with Bradley et al. U.S. 6,874,211 such that either reference can modify the other as discussed below.

Bradley discloses the invention of claims 1-3 and 12 as discussed in paragraph 8 above. However, Bradley does not show a conductive material in contact with the piezoelectric layer having a higher acoustic impedance than the conductive material not in contact with the piezoelectric (claim 5) with a diffusion barrier layer therebetween (claim 4) or the conductive materials being those recited (claims 7 and 8).

Fig. 6 of Lakin discloses an electro acoustic resonator that is solidly mounted on a substrate 65 comprising: a piezoelectric layer 62; a top electrode layer being a stack of conductive materials 67 and 69; a bottom electrode layer being a stack of conductive materials 68 and 70, wherein the conductive material 67, 68 that is in contact with the piezoelectric layer is tungsten (W), which inherently has a higher acoustic impedance than that of the aluminum conductive material 69, 70 that is not in contact with the piezoelectric layer; and between the conductive layers are other very thin layers (see col. 5, lines 43-50) which one of ordinary skill would have known included diffusion barrier layers; and wherein the resonators form filters (see col. 2, lines 33-38).

However, Lakin does not disclose the top electrode being thinner than the bottom electrode.

Bradley clearly shows that to form filters having multiple resonators with different resonant frequencies on the same substrate requires tuning that can be done by thinning the upper electrode of some resonators (see the abstract and Figs. 3A-B) to be thinner than the bottom electrode, or also by making the bottom electrode of some resonators thicker (see Fig. 4 and the discussion thereof).

Consequently, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the filters using multiple resonators of Lakin (Fig. 6) by having either thinned the top electrode or thickened the lower electrode of some resonators such that the top electrode would have been thinner than the bottom electrode, because such an obvious modification would have been merely extremely well known tuning methods in the acoustic resonator filter art as suggested by the exemplary teaching thereof by Bradley (see the abstract and Figs. 3A-4), and one of ordinary skill in the art would have known that the additional very thin layers between the stacked electrode layers of Lakin (col. 5, lines 43-50) would have included diffusion barrier layers that include the extremely well known titanium (Ti) which also would have been notoriously well known in the acoustic resonator art to provide the function of adhesion between materials that do not bond well being a function also suggested by Lakin (col. 5, lines 48-50).

It would have been equally obvious to one of ordinary skill in the art at the time the invention was made to have modified the filter of Bradley having resonators with a

top electrode thinner than a bottom electrode (Figs. 3A-4), by having provided the electrode layers be stacks of conductors with a high acoustic impedance material of tungsten in contact with the piezoelectric layer and an aluminum conductive material not in contact with the piezoelectric layer, with a diffusion barrier layer therebetween as suggested by the exemplary teaching thereof by Lakin (Fig. 6 and Fig. 9b and col. 5, lines 45-50), because such an obvious modification would have provided the advantageous benefits of increasing the effective coupling coefficient by the use of tungsten and decreasing the electrical losses by the use of the outer aluminum layer as suggested by Lakin (see the abstract), thereby providing resonators with reduces losses, both acoustic and electrical, and filters with wider bandwidths as also suggested by Lakin (see col. 2, lines 34-46).

12. Claims 10 and 11 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Bradley et al. U.S. 6,874,211 in view of Ylilammi U.S. 6,051,907 (cited by Applicants).

Bradley discloses the invention as discussed above except for the specific regions of thicknesses of the electrode layers for the specified materials for an operating frequency in the specified region of 2 GHz.

It should be noted that Bradley does use molybdenum electrodes and also suggests using other materials (see e.g. col. 3, lines 31-33) for a filter in the 2 GHz range (e.g. see 1.9GHz at col. 3, line 46). Also the scaling of electrode thicknesses is

inherently the inverse of the resonant frequency, since a thinner/smaller electrode makes the frequency higher and a thicker/larger electrode lowers the frequency.

Ylilammi teaches and provides evidence that one of ordinary skill in the art would take into consideration requirements of a particular application and parameters of the resonators, for example series resistance of resonators with thinned top electrodes like Bradley's, and adjust the thickness of electrodes of molybdenum and the thickness of the piezoelectric layer accordingly (see col. 7, lines 22-36). Additionally, one of ordinary skill in the acoustic resonator art would have known by common knowledge that the density and acoustic impedance of the electrode materials used, as well as the area of overlap of the electrodes, would have contributed to what is commonly known as the "weighted thickness" of the resonator (see other art of record cited below as evidence) which is what determines the operating resonant frequency thereof, and would have been able to easily determine the required thicknesses for other electrode materials such as platinum.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the acoustic resonator filter of Bradley (Figs. 3A-B or 4) by having designed a resonator filter with a frequency "in the region of" 2 GHz and either molybdenum or platinum electrode layers with a thickness "in the regions" recited, because such an obvious modification would have been a mere design adjustment that would have been based on the individual application requirements as explicitly suggested by Ylilammi (col. 7, lines 22-36) and on the extremely well known concept of the "weighted thickness" of acoustic resonators based on the density and

acoustic impedance of the materials used, and it would have been merely a routine calculation for one of ordinary skill in the art to convert the thicknesses of the molybdenum electrodes of Bradley to the proper thicknesses of platinum electrodes for the same frequency range, or any other electrode material for that matter.

Conclusion

13. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Ruby et al. U.S. 6,710,508 provides a discussion of the known concept of the weighted thickness of acoustic resonators (see col. 5, lines 44-60).

14. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Barbara Summons whose telephone number is (571) 272-1771. The examiner can normally be reached on M-Th, M-Fr.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Bob Pascal can be reached on (571) 271-1769. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

bs
January 4, 2008

Barbara Summons

BARBARA SUMMONS
PRIMARY EXAMINER